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NASA CR-156684

NTS-2

RETROREFLECTOR ARRAY

FINAL REPORT 906-FR-3001

(NASA-CR-156684) NTS-2 RETROREFLECTOR ARRAY
Final Report (Fairchild Industries, Inc.,
Germantown, Md.) 49 p HC A03/MF A01

N78-16356

CSSL 20E

Unclas

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For

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

CONTRACT NAS5-23604

APRIL 1977




FAIRCHILD
SPACE & ELECTRONICS COMPANY
Germantown, Maryland 20767

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NTS-2. Retroreflector Array

1.0 INTRODUCTION

This report summarizes the effort expended by Fairchild Space and Electronics Company (FSEC) under Contract NAS5-23604 in the design, fabrication and test of a Laser Retroreflector for the NTS-II Spacecraft. This work was conducted for Goddard Space Flight Center to support the laser experiment.

The design, development and test results of the NTS-II Laser Retroreflector are presented in the following pages and reflect the data required to meet the requirements of the contract.

2.0 SUMMARY

The NTS-II Laser Retroreflector consists of a honeycomb tray onto which are mounted 44 fused silica cube corners with a 50-millimeter hexagonal entrance pupil and a single infrared cube. The cube corner layout on the honeycomb plate is presented in Figure 1. All cube corners and the mounting tray are Government Furnished Equipment. A thermal shield with a highly reflective outer surface and a black inner surface was incorporated to shroud the assembly protecting it from extreme high temperature exposure thus reducing cube corner thermal distortions to a minimum.

A dummy retroreflector, utilizing simulated aluminum cube corners was fabricated and vibration tested to qualification levels to substantiate the integrity of the tray and cube mounting clips. This dummy was further used in the spacecraft spin balance test.

The flight Laser Retroreflector was tested to the flight level vibration spectrum to verify that the unit will survive its expected vibration environment. During this test several GFE cube corners exhibited slight crazing at the clip support mounting holes. These cubes were reworked and retested and proved to be satisfactory.

3.0 DESIGN AND DEVELOPMENT

3.1 Mechanical Design Parameters

Under this contract FSEC was directed to fabricate one (1) dummy NTS-II Retroreflector Array and one (1) Flight NTS-II Retroreflector Array. The array consisted of the following parts:

- Support Tray (1)
- Cube Corner Mounting Clip (45)
- Silica Cube Corner (44)
- Infrared Cube Corner (1)
- Thermal Shield (1)
- Thermal Shield Standoff (18)

3.2 Flight Array

3.2.1 Support Tray

The support tray was GFE supplied Naval Research Laboratory P/ N0000325. It is a .500-thick panel of 1/4 - 5052-001 honeycomb core with .012 thick, 2024-T3 face skins. Delron inserts are imbedded in the panel providing hard spots for interface with the spacecraft and to support the cube corners.

3.2.2 Cube Corner Mounting Clip

The cube corner mounting clip, FSEC P/ N906-001-0001, is a tri-legged clip made from BeCu. These clips were designed such that the leg is pre-deformed to provide a positive force to three faces of the installed silica cube corner. Protrusions at the ends of the clip legs are seated into the .156 diameter holes within the cube corner. A nut incorporated into the base of the clip permits mounting to the tray by means of a screw through the inserts in the tray. The following analysis verifies that the clip design can support the cube corner throughout the spacecraft vibration environment.

3.2.3 Cube Corners

The cube corners, 44 silica and one infrared, are GFE. They were mounted into their clips and subsequently mounted onto the tray.



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PAGE 1

CUBE CORNER CLIP - VTS-2

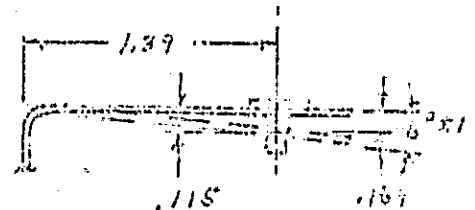
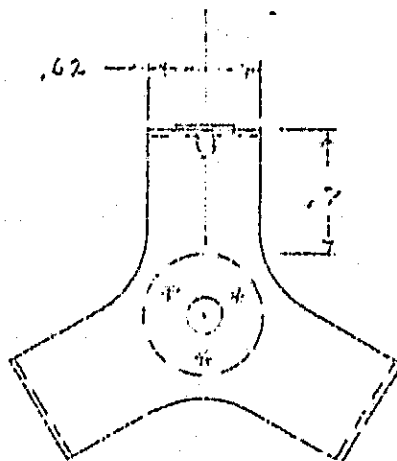
DWG. 906-001-0001.

Material: Beryllium Copper BERYLCO 2.5, COND. A,
age-hardened

$$F_{tu} = 165 \text{ KSI} \quad F_{ty} = 140 \text{ KSI}$$

$$E = 18.5 \times 10^6 \text{ KSI}$$

$$t = .025$$

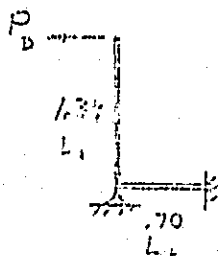


$$\delta \text{ to straighten to right angle}$$

$$= 1.39 \sin 7^\circ = .169 \text{ inches}$$

CUBE INSTALLATION ANALYSIS

The tab must be deflected at least 0.070" plus .169 to
install cube or .259".



P_D = Force required to deflect tab
.259"

$$\delta = \frac{P_D}{EI} \left(\frac{L_1^3}{6} + \frac{L_1^2 L_2}{2} \right)$$

$$P_D = \frac{12 \delta EI}{L_1^2 (4L_1 + 3L_2)} = 3.89(10)^6 \text{ I}$$

$$M_{max} = 1.39 P_D$$

$$f_b = \frac{M_{max}}{2I} = \frac{1.39 P_D t}{2I} = 2.70(10)^6 t$$

For $t = .025$, $f_b = 67,500 \text{ psi}$ installation stress

$$\text{Preload } (\delta = .169) = \frac{.169}{.259} (2.89(10)^6) (.62) (.025) / 12 = 2.95 \text{ lbs MAX}$$

$$\text{Preload } f_b = (.169 / .259) (67,500) = 44,100 \text{ psi MAX}$$

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F. A. C.

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PAGE 2-

CUBE CORNER CLIP - NTS 2

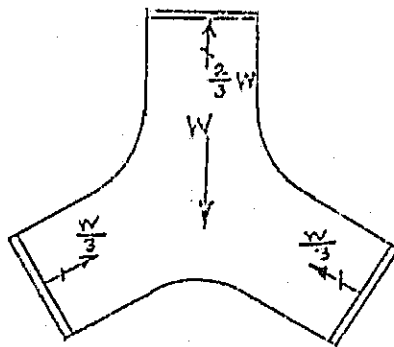
RANDOM VIBRATION ANALYSIS

$$f_n = \frac{1}{2\pi} \sqrt{\frac{g}{\delta}} \quad \text{where } g = 1.0 \text{ G deflection}$$

Cube corner weight = .162 lb.

From Pg. 1, $P_d = 2.05 \text{ lb}$ for 0.169" deflection

For a frictionless system at clamp-to-cube-corner.



$\frac{2}{3}$ of cube corner weight = .108 lb.

$$\delta \text{ for } 1.0 \text{ G} = .108 \left(\frac{.169}{2.05} \right) = .00890''$$

$$f_n = \frac{1}{2\pi} \sqrt{\frac{386}{.0089}} = 33 \text{ Hz}$$

$$g_{\text{RMS}} = \sqrt{\frac{\pi}{2} \text{PSD } f_n Q}$$

PSD @ 33 Hz at QUAL LEVEL = .02 G²/Hz

With 2% damping,

$$g_{\text{RMS}} = \sqrt{\frac{\pi}{2} (.02) (33) (50)} = 7.2$$

$$g_{3\sigma} = 21.6$$

$$f_b = .108 (21.6) (1.39) (6) / (.62) (.025)^2 = 50,200 \text{ n/s}$$

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CUBE CORNER CLIP - VTI-2

COMBINED PRELOAD PLUS RANDOM VIBRATION BENDING

$$f_b = 44100 + 50200 = 94300 \text{ PSI}$$

$$\underline{M.S.} = \frac{140000}{94300} - 1 = \underline{.48}$$

PRELOAD ANALYSIS

$$\text{MINIMUM PRELOAD (for } 5^\circ) = 2.05 \left(-\frac{5}{2} \right) = 1.46 \text{ \#}$$

Required preload is $gW/3$ where g is 35 random vibration response

$$\text{Required preload} = 21.6(.162)/3 = 1.17 \text{ \#}$$

$$\underline{M.S.} = \frac{1.46}{1.17} - 1 = \underline{.25}$$

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3.2.4 Thermal Shield

During the course of the program it was established that a thermal shield was required to preclude the trapping of heat between the cube corners. The design of the thermal shield FSEC P/ N906-001-0002, required a highly reflective exterior surface to reflect solar energy and a black interior surface to absorb and dissipate the heat from around the cube corners. Hexagonal cutouts over each cube permit cube viewing.

The following analysis substantiates the structural capability of the heat shield to withstand dynamic loads imposed on the heat shield.

3.2.5 Laser Retroreflector Assembly

The laser retroreflector assembly is depicted on FSEC Drawing 906-001-004. Each cube corner location, with respect to the tray, was recorded and is depicted in Figure 1. In addition, the reference axis of the cube corner is mounted in the direction of the arrow shown for each cube corner in Figure 1.

3.3 Dummy Array

A dummy array to simulate the flight array mass and mounting configuration was constructed. The dummy array consisted of a flight tray with 44 mass simulated aluminum cube corners and one dummy BaF₂ cube corner located at position 21. The thermal shield was simulated with an aluminum sheet mounted over the cube corners.

This unit was vibration tested to specified qualification levels and delivered to the Naval Research Laboratory for use in the spin balance test.

3.4 Shipping

The NTS-II Laser Retroreflector will be shipped and stored in a container with a protective cover FSEC P/ N906-001-0005. The protective cover is designed to be used as a handling fixture for spacecraft installation as well as serving as a protective shield. The cover is fabricated of a clear plexiglass material to permit cube inspection without removal of the cover.

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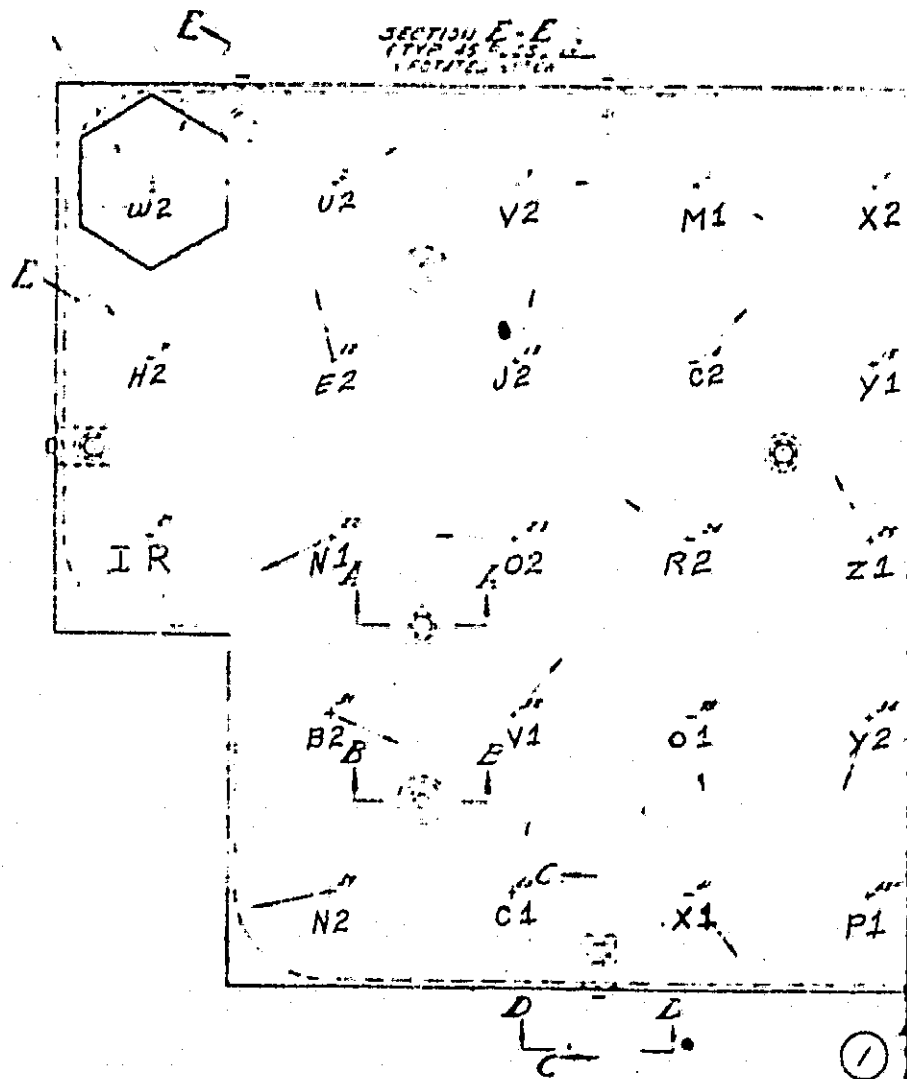
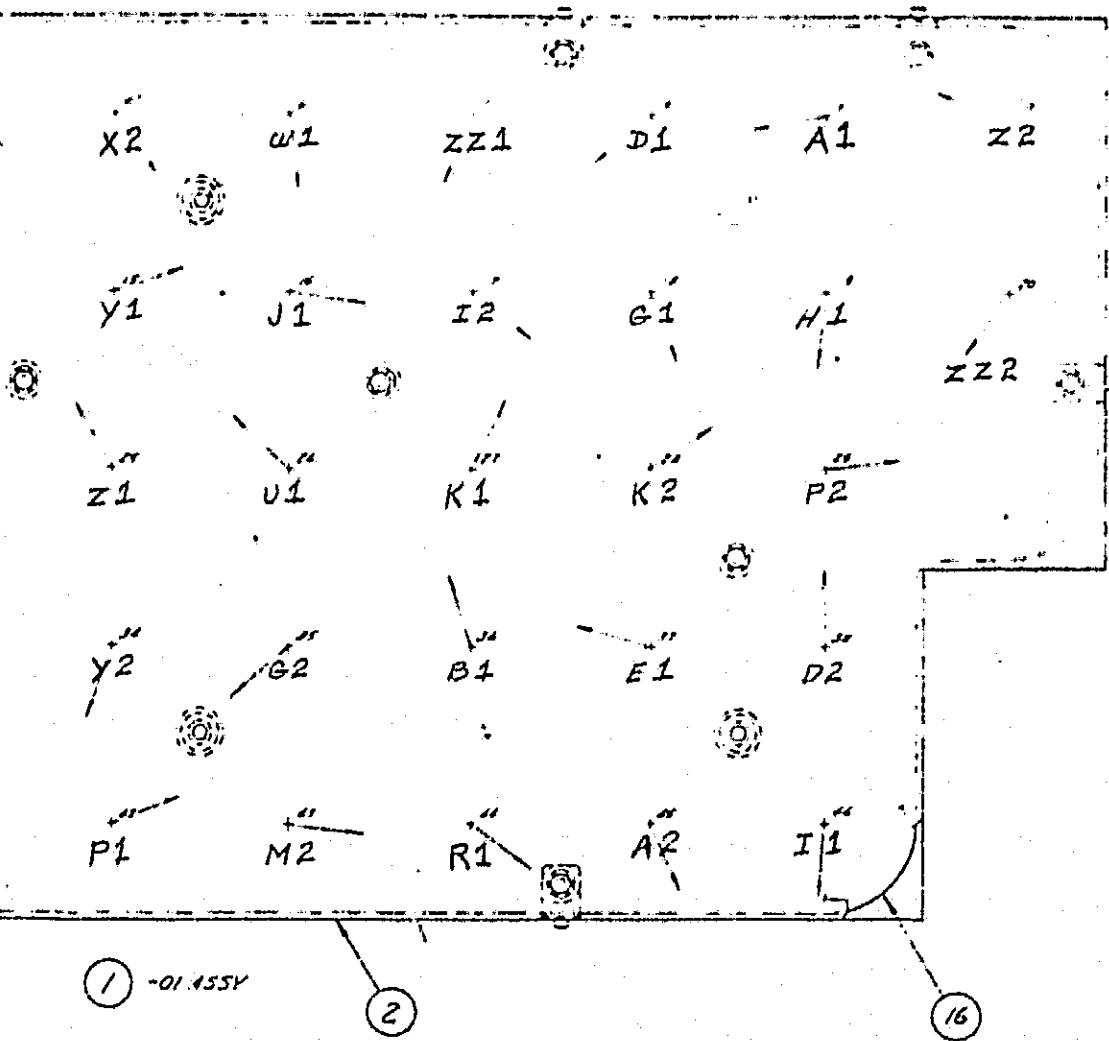


Figure 1. NTS-2 Retroreflector Cub

FOLDOUT FRAME

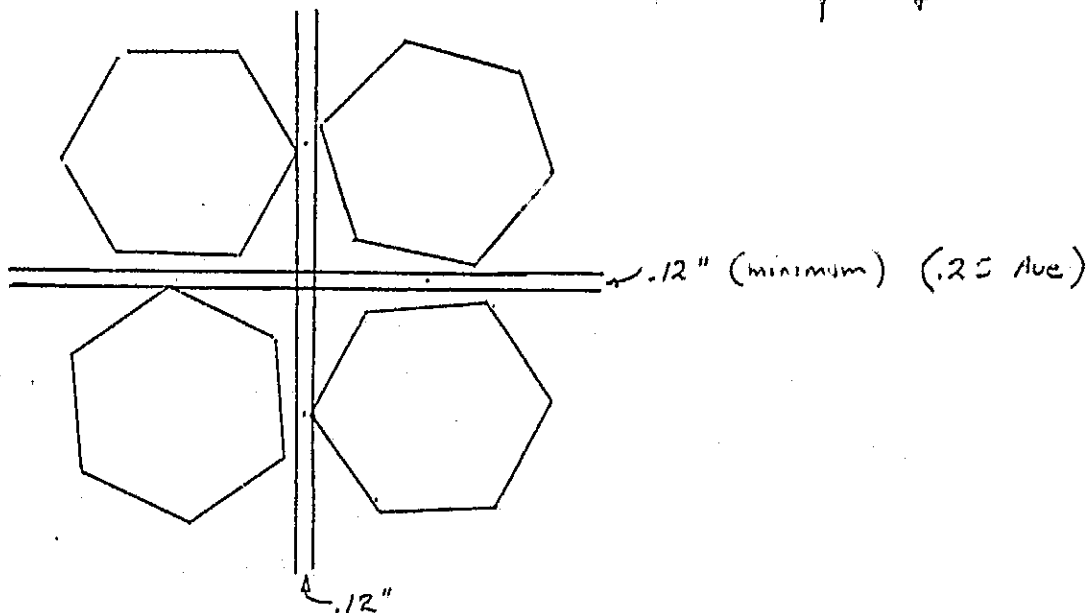


Detector Cube Layout

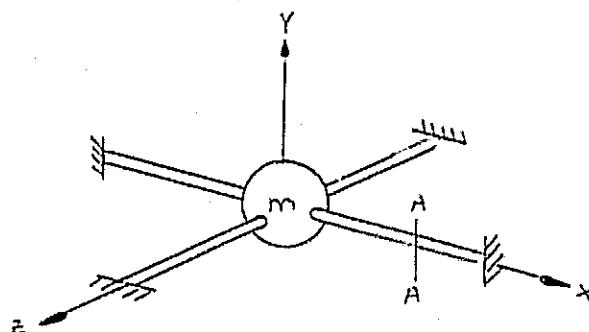
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FOLDOUT FRAME

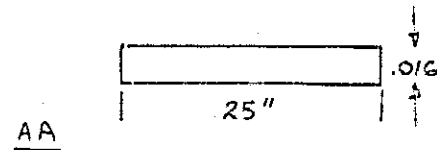
For a worst case (worst case f. R/VL occurs at highest frequency)
(Typical)



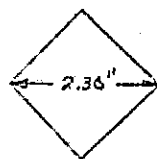
Idealized Case



MAT'L: Aluminum



mass: Averaged as a square



$$A = [2.30(\sin 45^\circ)]^2 = 2.644$$

$$W = 2.644(.016)(.10) = 4.231 \cdot 3 \text{ lbs}$$

$$m = 1.096 \cdot 5 \frac{\text{lb} \cdot \text{sec}^2}{\text{in}}$$

$$K_{yy} = 2 \left[\frac{192EI}{\ell^3} \right] \text{ where } \ell = 4.6"$$

$$I = \frac{(.016)^3 (.25)}{12} = 8.192 \cdot 8$$

$$K_{yy} = 3.232 \frac{\text{lb}}{\text{in}}$$

$$K_{yy} = K_{zz} = \frac{AE}{\ell} + \frac{192EI_2}{\ell^3}$$

$$I_2 = \frac{(.25)^3 (.016)}{12} = 2.08 \cdot 5$$

$$A = 4.0 \cdot 3$$

$$K_{xx} = \left(\frac{4.0 \cdot 3}{4.6} + \frac{192(2.08 \cdot 5)}{4.6^3} \right) 10^7$$

$$K_{xx} = 9.10 \cdot 3 \frac{\text{lb}}{\text{in}}$$

$$\omega_n (\text{translational - } y) = \sqrt{\frac{3.232}{1.096 \cdot 5}} = 543.0 / \text{sec} = \boxed{36.4 \text{ Hz}}$$

$$\omega_n (\text{axial - } x \text{ - } z) = \sqrt{\frac{9.1+3}{1.016 \cdot 5}} = 28,814 / \text{sec} = \boxed{4,586 \text{ Hz}} \quad (\text{beyond range of anticipated vibrations})$$

loads

$$G_{in} = 3 \sqrt{\frac{\pi}{2} Q f_n S'} \quad (g' =) \quad S'(\text{ref}) = .170$$

$$Q = \text{Amplification} = \frac{1}{\delta P} \quad \delta_{al} = 1.25\%$$

$$\therefore Q = 40$$

translational

$$a_g = 3 \sqrt{\frac{\pi}{2} 40 (36.4) .170} = 79.7 \frac{g}{g}$$

$$F = 79.7 (1.096 \cdot 5) (12) (32.2) = .338 \text{ lbs}$$

$$\sigma_{max} = \frac{mc}{I} = \frac{(9.718 - 2)(.008)}{4.096 \cdot 8} = \boxed{18,980 \text{ psi}}$$

$$M (\text{at minimum } t) = \frac{.338 (1.15)}{4} = 9.718 \text{ in-lbs}$$

$$t_{min} = .12$$

$$\sigma_{design} = 1.1 (18.98 \approx 3) = 20,876 \text{ psi}$$

$$I = \frac{(.016)^2 (.12)}{12} = 4.096 \cdot 8 \text{ in}^4$$

$$c = .008 \text{ in}$$

$$T_{max} = \frac{F}{A} = \left(\frac{.338}{4} \right) / 1.92 \cdot 3 = 44.0 \text{ psi}$$

$$A = (.016)(.12) = 1.92 \cdot 3$$

$$\text{Yield Al} \approx 37,000 \text{ psi}$$

$$M.S. = \frac{37}{20.88} - 1 = \underline{\underline{0.77}}$$

LASER REFLECTOR COVER

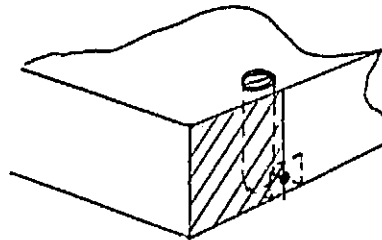
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Skirt Analysis

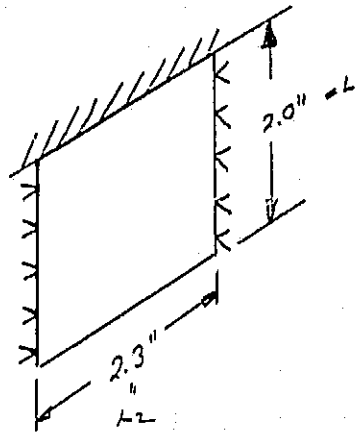
A) RANDOM VIBRATIONAL LOADS

1) Worst Case (highest f_n)

Actual



Idealized



$$t = .016$$

$$E = 10^7$$

$$k = \frac{Et^3}{4L_2^3L_1} (16L_1^4 + L_2^4) = \frac{10^7 (.016)^3}{4(2.3)^3(2.0)^3} (16(2.0)^4 + 2.3^4)$$

$$k = 29.88 \frac{\text{lb}}{\text{in}}$$

$$m_t = \frac{2.0 \times 2.3 \times .016 \times .10}{386} = 1.907 \times 10^{-5} \frac{\text{lb sec}^2}{\text{in}}$$

assume $\frac{1}{3}$ mass at max deflection

$$m = 6.356 \times 10^{-6} \quad \omega_n = \sqrt{\frac{29.88}{6.356 \times 10^{-6}}} = 2168 \text{ } \frac{1}{\text{sec}} = 345 \text{ Hz}$$

$$a_g = 3 \sqrt{\frac{\pi}{2} Q S_n S'}$$

$$S = .170 \text{ (Ref)}$$

$$Q = 40 \rightarrow \text{aluminum}$$

$$a_g = 3 \sqrt{\frac{\pi}{2} 40 (345) .17} = 182.1 \text{ g}$$

$$F = m a = (1.907 \times 10^{-5} \times 386) 182.1 = 1.34 \text{ lbs}$$

assume all moments taken out along cantilevered side

$$\sigma_{\max} = \frac{M c}{I} = \boxed{27,308 \text{ psi}}$$

$$M = 1.34 (2.0) = 2.68 \text{ in-lb}$$

$$\sigma_{\text{design}} = 1.1 (27,308) = 30,039 \text{ psi}$$

$$I = \frac{2.3 (.016)^3}{12} = 7.851 \times 10^{-7}$$

$$f = \frac{F}{A} = \frac{1.34}{6.3 (.016)} = 13.4 \text{ psi negligible}$$

$$M.S. = \frac{37.0}{30.04} - 1 = \underline{\underline{.228}}$$

2) Two sections wide

$$(ie L_1 = 2.0, L_2 = 4.6 \text{ "})$$

$$k = \frac{10^7 (.016)^3}{4 (4.6)^3 (2.0)^3} (16 (2.0)^4 + 4.6^4) = 9.254 \frac{\text{lb}}{\text{in}}$$

$$m = \frac{2.0 \times 4.6 \times .016 \times .10}{386} = 3.81 \times 10^{-5}$$

$$\frac{m}{3} = 1.27 \times 10^{-5}$$

$$\omega_n = \sqrt{\frac{9.254}{1.27 \times 10^{-5}}} = 854 \text{ R/Sec} = 135.8 \text{ Hz}$$

$$a_g = 114.3 \text{ g}$$

$$F = 1.68 \text{ lbs}$$

$$M = 1.68 \times 2 = 3.36$$

$$I = \frac{4.6 (.016)^3}{12} = 1.57 \times 10^{-6}$$

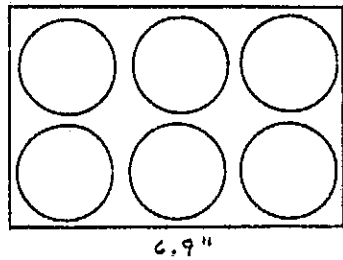
$$\sigma_{\max} = \frac{3.36 (.008)}{1.57 \times 10^{-6}} = 17,118 \text{ psi}$$

$$\sigma_{\text{design}} = 1.1 (17,118) = 18,830.0$$

$$M.S. = \frac{37.0}{18.83} - 1 = \underline{\underline{.965}}$$

LASER REFLECTOR COVER

(Maximum deflection)



4.6" worst case (2,3) holes

Assume average properties of a rectangular plate

perforated to 36.6% Area

$$\text{Volume} = .366(4.6 \times 6.9)(.016) = .18576$$

$$t_{ave} = \frac{.18576}{31.74} = .00585 \approx .006$$

$$K = \frac{4Et^3}{L_1^3 L_2^3} (L_1^4 + L_2^4) = .7334 \frac{\text{lb}}{\text{in}}$$

assume $\frac{1}{3}$ mass concentrated at center

$$W = .18576(.10) = 1.86 \times 10^{-2} \quad \frac{W}{3} = 6.2 \times 10^{-3}$$

Assume 4g loading

$$F = 2.48 \times 10^{-2}$$

$$\Delta = \frac{F}{K} = 3.38 \times 10^{-2} \text{ inches}$$

The array assembly with the protective cover will be placed in a poly-ethelene bag sealed for environmental protection during shipment. The unit is placed in an "off-the-shelf" foot locker, serving as a container, with adequate protective polyurethane cushioning for shipment.

4.0 DRAWING LIST

<u>Drawing No.</u>	<u>Part Name</u>	<u>Originator</u>
A-107-1313-90	Cube Corner	GSFC
0000325	Laser Reflector Mounting Base	NRL
906-001-0001	Clip Assembly	FSEC
906-001-0002	Shield Assembly	FSEC
906-001-0003	Shield Standoffs	FSEC
906-001-0004	NTS-II Laser Retroreflector Assembly	FSEC
906-001-0005	Protective Cover	FSEC

5.0 TEST

5.1 Vibration

Vibration testing of the NTS-II Laser Retroreflector was conducted in accordance with the requirements as defined in the Statement of Work. The units were tested to NTS-II Spacecraft component levels depicted in Figures 2 and 3 specified by NRL.

5.1.1 Dummy Array

Subsequent to completion of fabrication and assembly of the dummy array in its original configuration the dummy array was subjected to a vibration exposure as presented in Figure 2 to substantiate the mounting clip design. No adverse effects were observed as a result of this test. The test data are presented in Figures 4, 5 and 6.

Subsequent to redesign, the dummy unit was modified to reflect the revised configuration with one unpolished flight cube installed. A simulation thermal shield was placed over the aluminum cubes, then this array was subjected to a vibration exposure as presented in Figure 3. No adverse effects to the unit, cubes, or clips were observed as a result of this test. The test data are presented in Figures 7, 8 and 9.

5.1.2 Flight Array

After completion of fabrication and assembly of the flight array in its final configuration, the unit was subjected to a vibration exposure as presented in Figure 3. Subsequent to this test inspection revealed 9 of the 44 fused silica cube corners had crazed or chipped areas at the clip mounting holes. The test data are presented in Figures 10, 11 and 12.

5.1.3 Corrective Action/Retest

Corrective action, consisting of applying RTV 566 into each mounting hole of the cube corners which had suffered crazing or chipping, was implemented. These cube corners were then mounted on the dummy array and subjected to a vibration exposure presented in Figure 3. No further crazing or chipping was observed following this test. The test data are presented in Figures 13, 14 and 15.

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RANDOM VIBRATION COMPONENT
QUALIFICATION TEST LEVEL

1/9/75

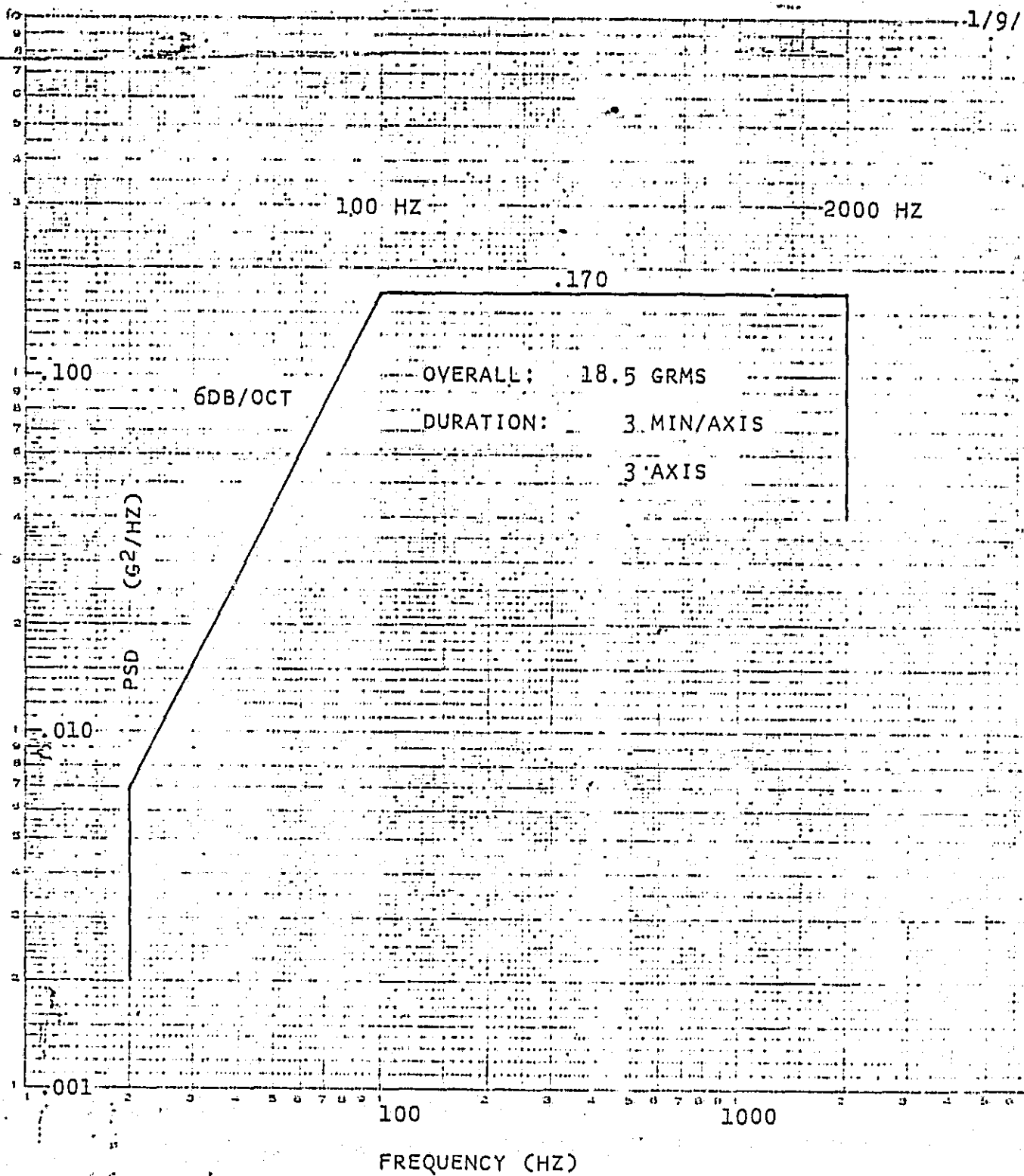


Figure 2

RANDOM VIBRATION COMPONENT -
ACCEPTANCE TEST LEVEL

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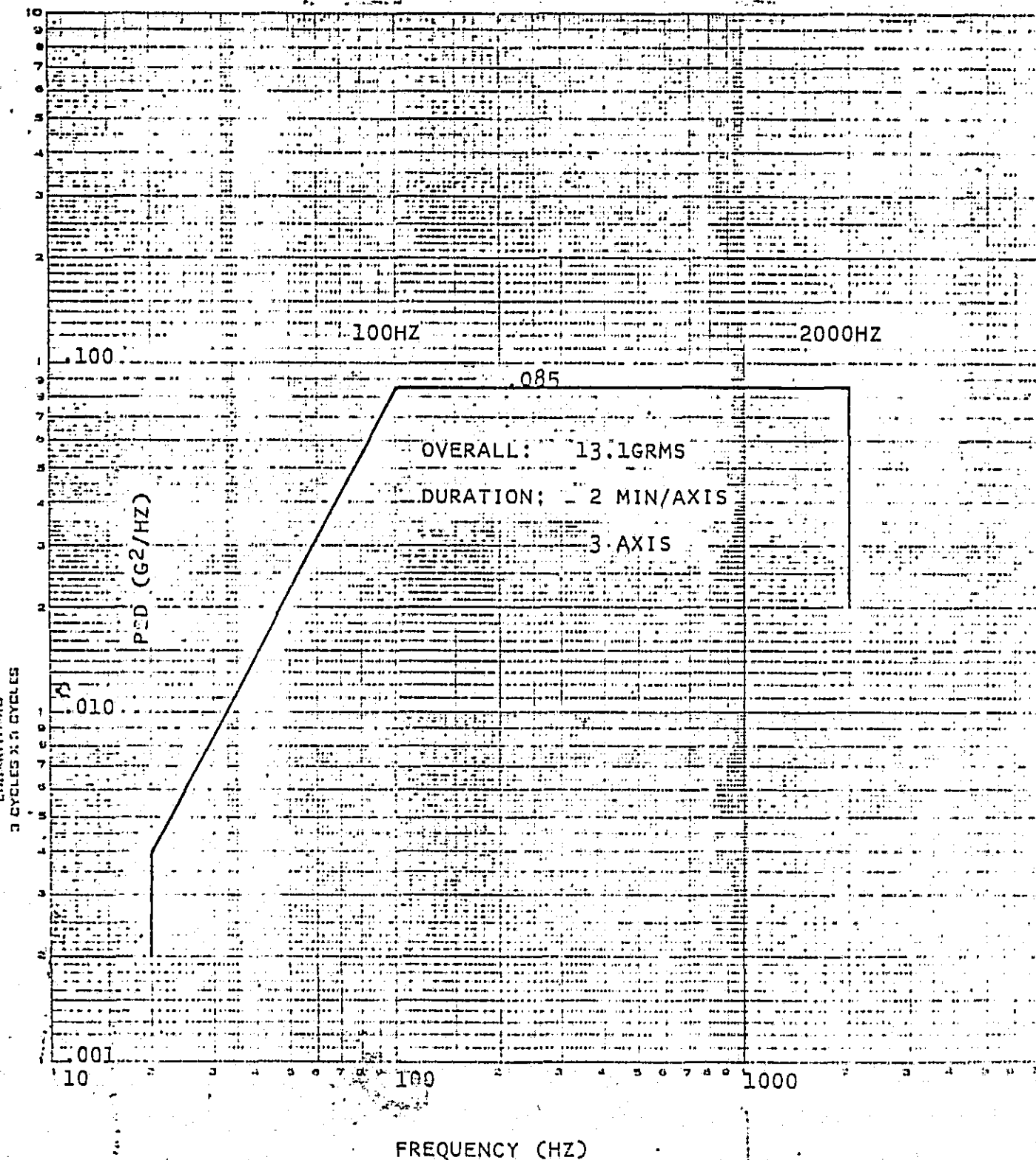


Figure 3

5.2 Optical Test

Optical testing of the NTS-II Retroreflector Array was conducted at Goddard Space Flight Center using GSFC personnel and equipment.

5.3 Spacecraft Testing

During the course of the program the dummy array was subjected to spacecraft spin balance testing. In addition, the flight array, with dummy cubes replacing the crazed cubes only, was subjected to spacecraft vibration and spin balance tests. No adverse effects were experienced as a result of these tests.

FREQUENCY HERTZ

10 200 300 400 500 600 700 800 900 1000 1200 1400 1600 1800 2000



0.170 G/H₂

6dB/oct.

TOTAL: 18.56 RMS

Duration: 3 minutes

FZ

MANUFACTURER

SPECIFICATION

Lat Y-Axis OPERATOR

ENG. Dummy

TOTAL GMS. 18.56 RMS

TEST ENG.

SERIAL NO.

DATE

8-23-76

G.S.I.

CUSTOMER

Figure 4. Vibration Test

FREQUENCY HERTZ

10 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900

6dB/oct

TOTAL: 18.5 GRMS

0.170 G²/Hz

Duration: 3 MINUTES

MANUFACTURER

FL

MODEL NO.

ENG DUMMY

SERIAL NO.

SPECIFICATION

As per X-RAY OPERATOR

TOTAL GRMS.

18.5 GRMS TEST EM.

DATE

8-21-76

G.S.I.

Figure 5. Vibration Test

CUSTOMER



0.170
G³/Hz

TOTAL: 18.5 GRMS

Duration: 3 MINUTES

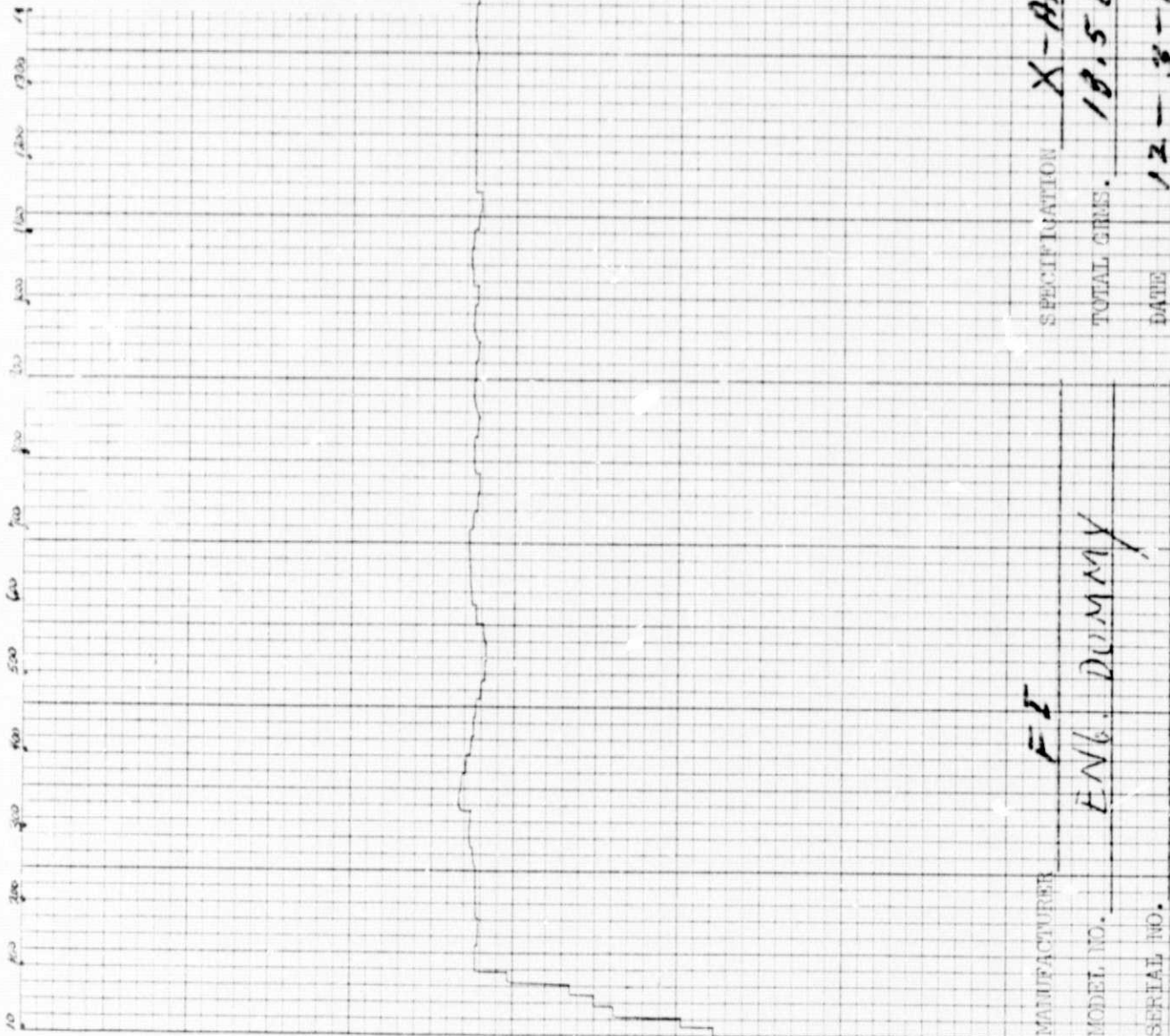
600/0CT

MANUFACTURER	ENG: DUMMY	SPECIFICATION	2 - Hrs	OPERATOR	W. L. B.
MODEL NO.		TOTAL GRMS.	18.5 GRMS	TEST ENG.	G. J. B.
SERIAL NO.		DATE	8-23-76	G.S.I.	

Figure 6. Vibration Test

CUSTOMER

FREQUENCY HERTZ

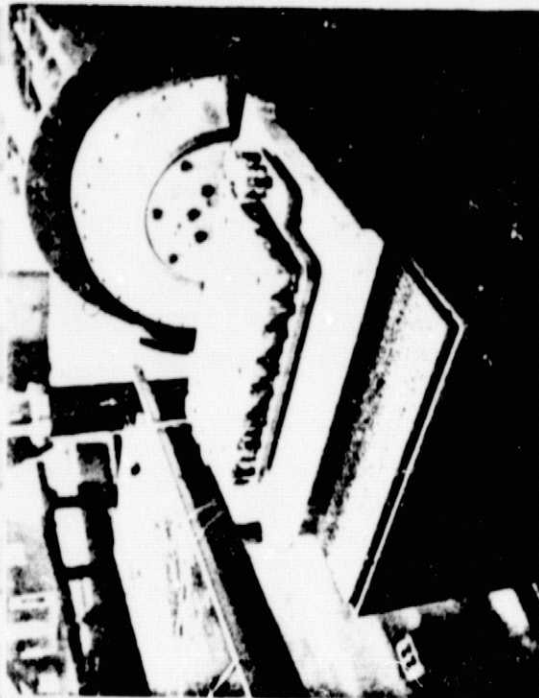
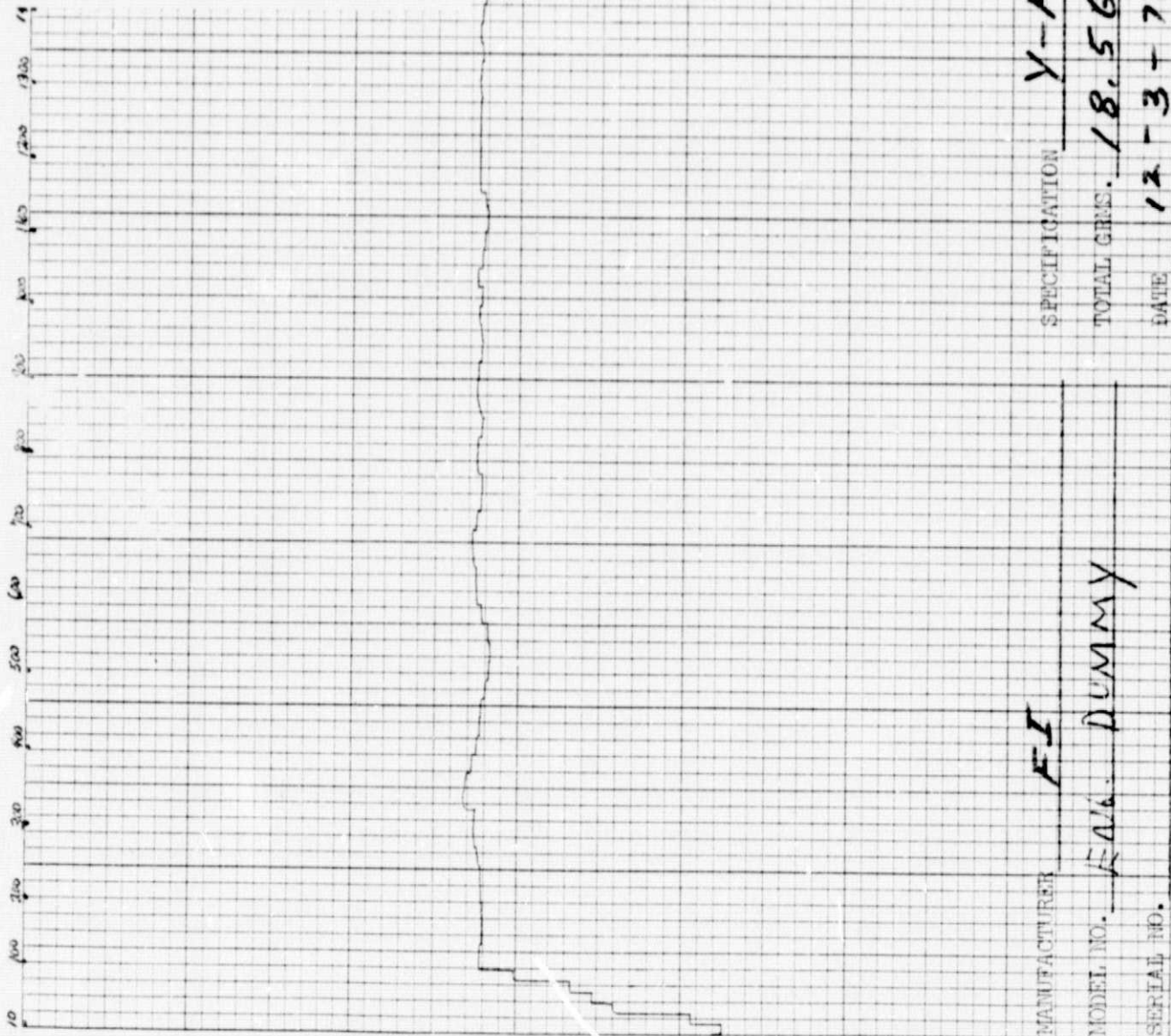


MANUFACTURER	FL	SPECIFICATION	X-Axis	OPERATOR	W. Dwyer
MODEL NO.	ENV. DUMMY	TOTAL GMS.	18.5 G-RMS	TEST ENG.	A. Brown 12/3/12
SERIAL NO.		DATE	12-8-76	G.S.I.	

CUSTOMER

Figure 7. Vibration Test

FREQUENCY HERTZ



MANUFACTURER **FI**

MODEL NO. **DUMMY**

SERIAL NO.

SPECIFICATION **Y-Axis**

TOTAL GMS. **18.56-RMS**

DATE **12-3-76**

OPERATOR **J. P. R.**

TEST ENG. **G. J. R.**

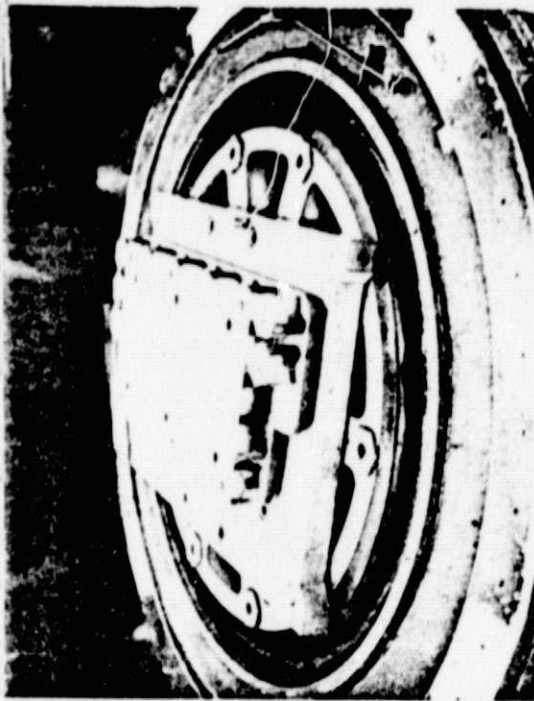
G.S.I.

CUSTOMER

Figure 8. Vibration Test

FREQUENCY HERTZ

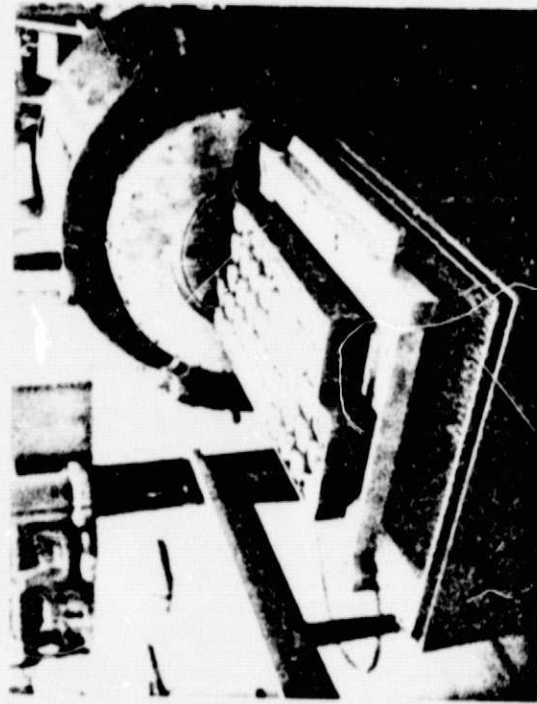
10 200 300 400 500 600 700 800 900 1000 1200 1400 1600 1800 2000



MANUFACTURER	FZ	SPECIFICATION	Z-Axis	OPERATOR	adg
MODEL NO.	SANFERNAT DUMMY	TOTAL GRMS.	18.56 RMS	TEST ENG.	ELB
SERIAL NO.		DATE	12-3-74	G.S.I.	

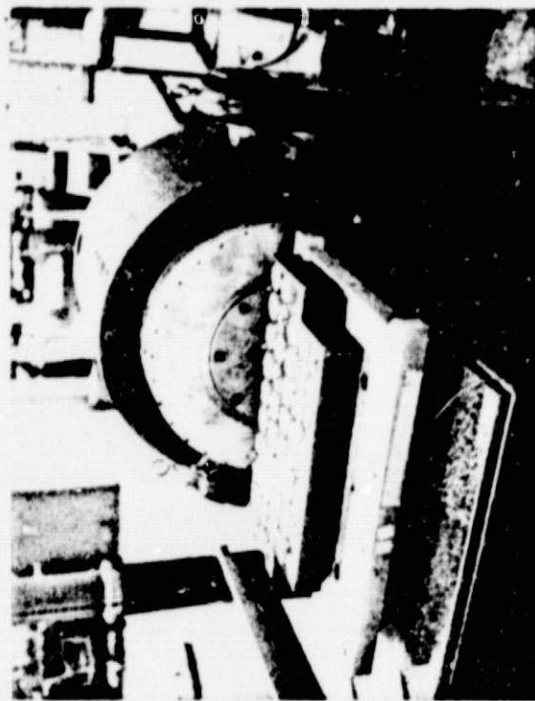
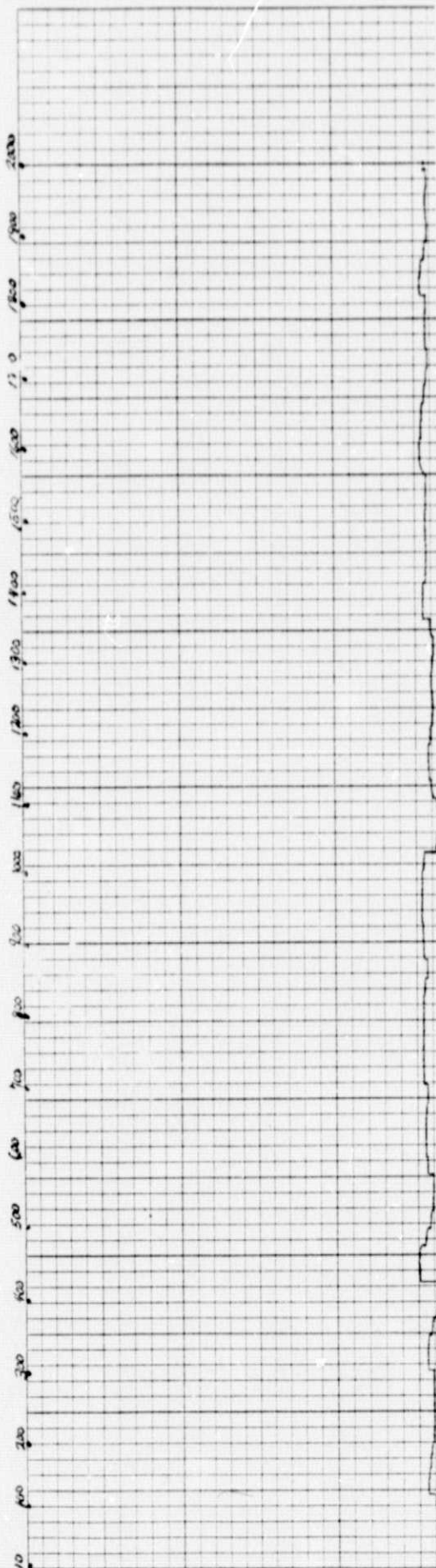
CUSTOMER

Figure 9. Vibration Test



MANUFACTURER	F2	SPECIFICATION	X-HYS	OPERATOR	J. L. R.
MODEL NO.	Refractometer	TOTAL GMS.	13.1 G RMS	TEST ENG.	G. S. I.
SERIAL NO.		DATE	2/28/77	G.S.I.	
				CUSTOMER	

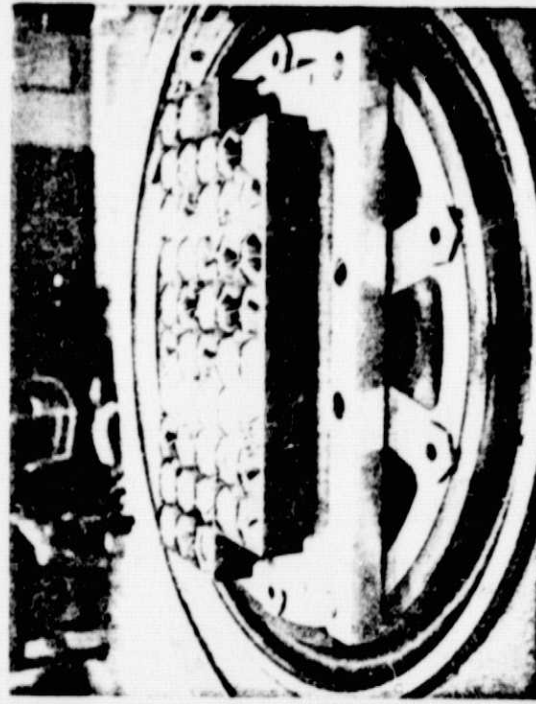
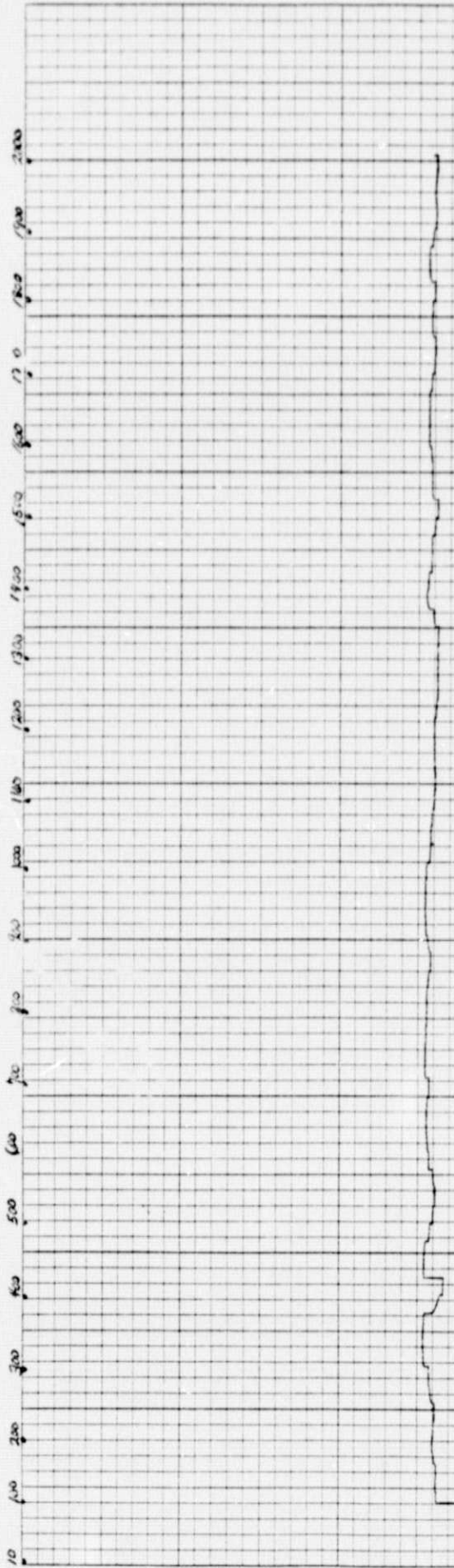
Figure 10. Vibration Test



MANUFACTURER	FI	SPECIFICATION	Y-Axis	OPERATOR	J. Lee
MODEL NO.	Reference	TOTAL GMS.	13.16 RMS	TEST ENG.	C. J. Jones
SERIAL NO.		DATE	2/28/77	G.S.I.	

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Figure 11. Vibration Test



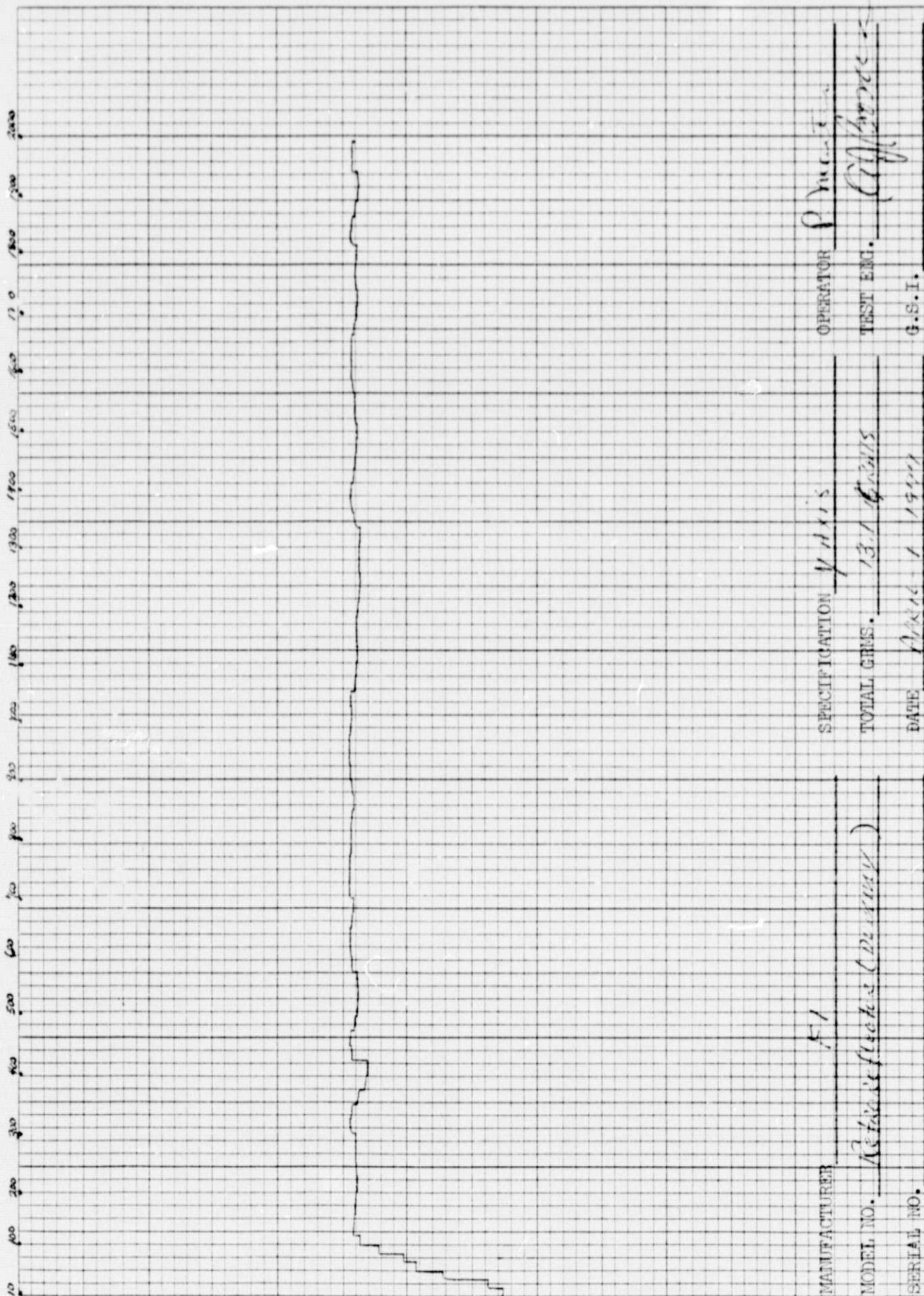
MANUFACTURER	FZ	SPECIFICATION	Z - Axis	OPERATOR	J. King
MODEL NO.	Retractor	TOTAL GMS.	13.1 G RMS	TEST ENG.	Defina
SERIAL NO.		DATE	2/28/77	G.S.I.	

Figure 12. Vibration Test

CUSTOMER



Figure 13. Vibration Test



MANUFACTURER	FL	OPERATOR	P. M. C. T. M.
MODEL NO.	ASTRA-6-FL-100 (22.1000)	TEST ENG.	C. J. H. R. D. C.
SERIAL NO.		DATE	12/14/11 1941
		G.S.I.	

Figure 14. Vibration Test

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FREQUENCY HERTZ

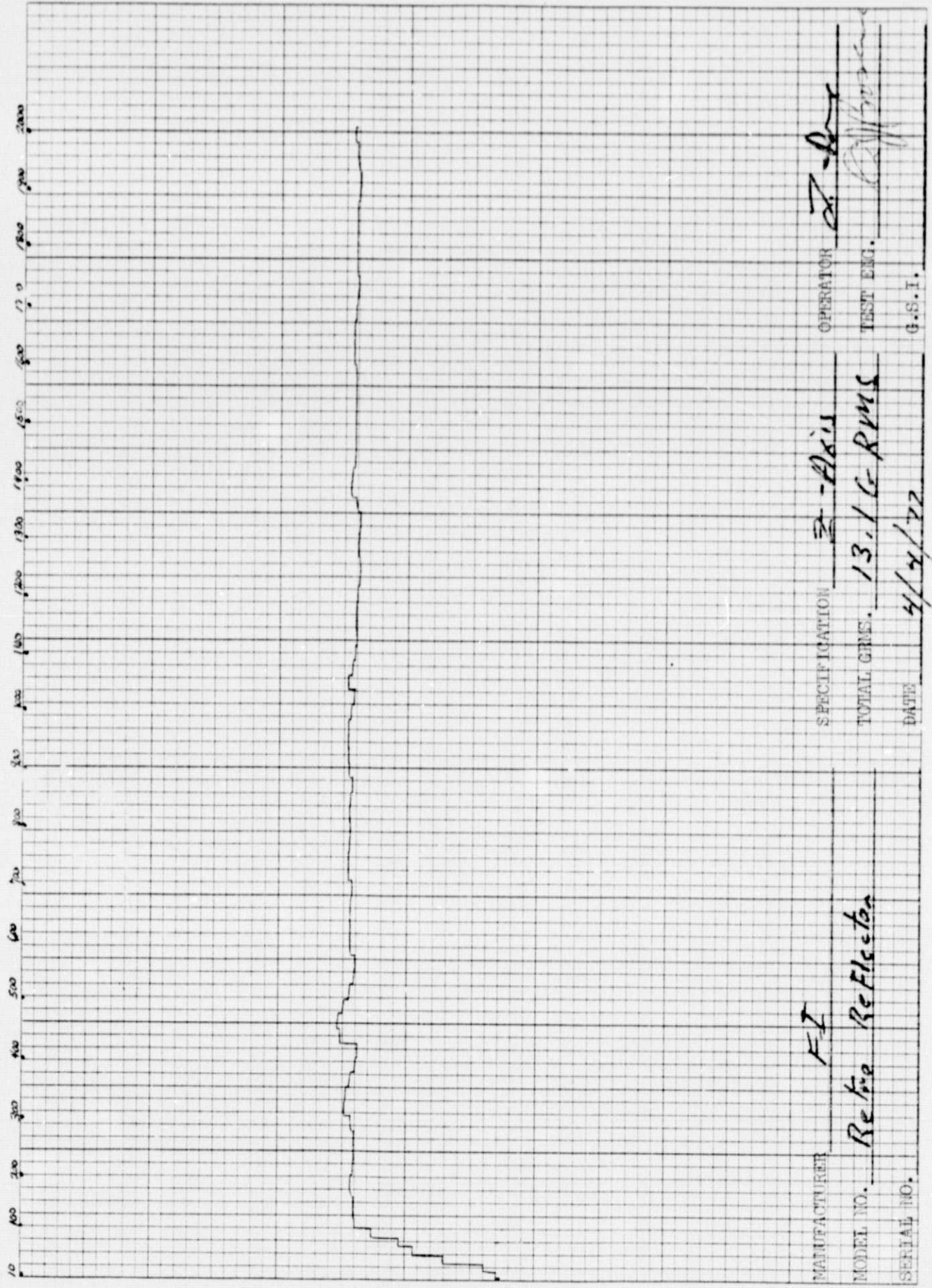


Figure 15. Vibration Test

CUSTOMER

APPENDIX A

RETROREFLECTOR ARRAY DRAWINGS

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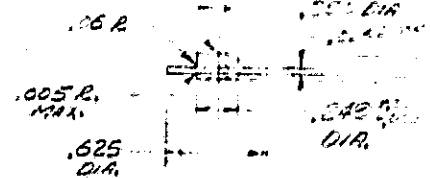
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NOTES

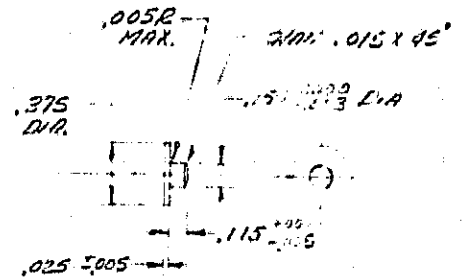
1. DIMENSION $\sqrt{R^2 + H^2}$ AT 90 ANGLE OF BEND
(THEORETICAL) THIS DIMENSION TO BE USED TO
ESTABLISH HEEL OF BEND.

ASE HARTMAN CO. 3400 5000 F. 1000

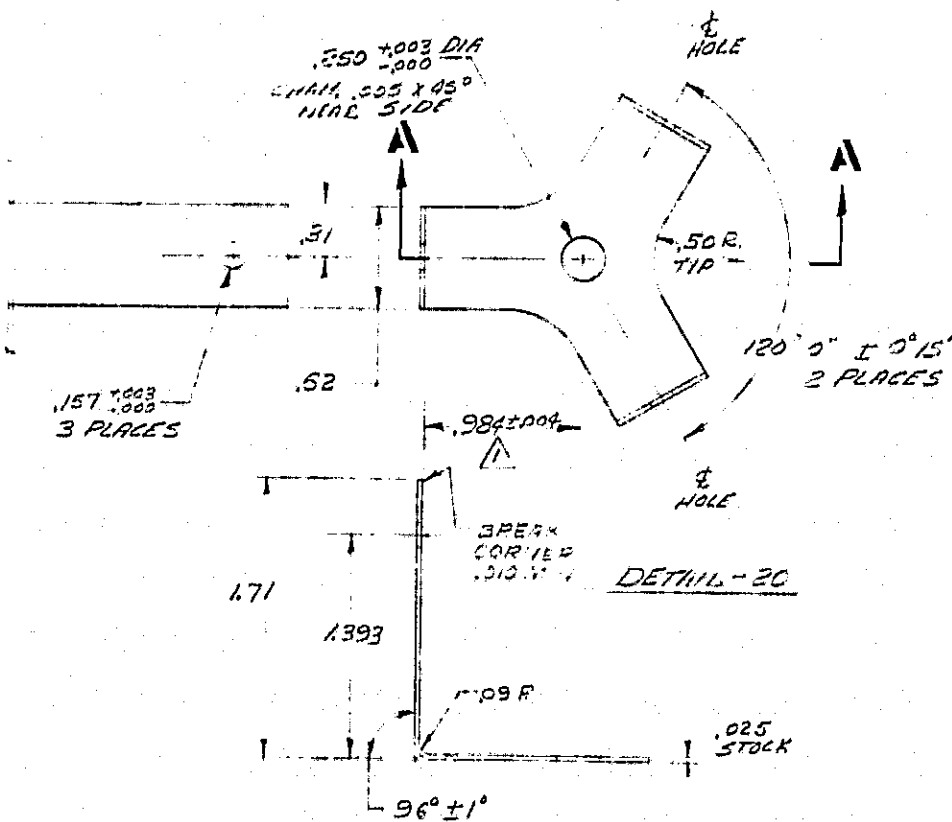
#2-21-36
TILE



DETAIL -21



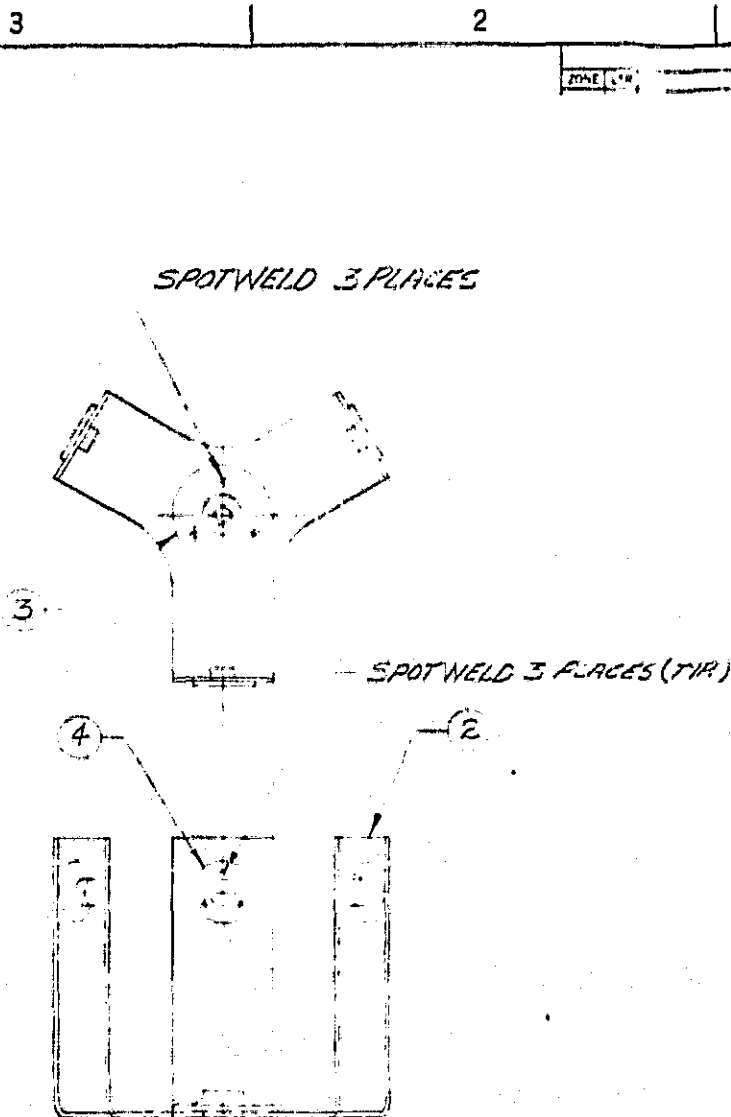
DETAIL -22



DETAIL -20

SECTION A-A

2 REPRODUCIBILITY OF THE
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① -01 ASSEMBLY 2

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NOTES:

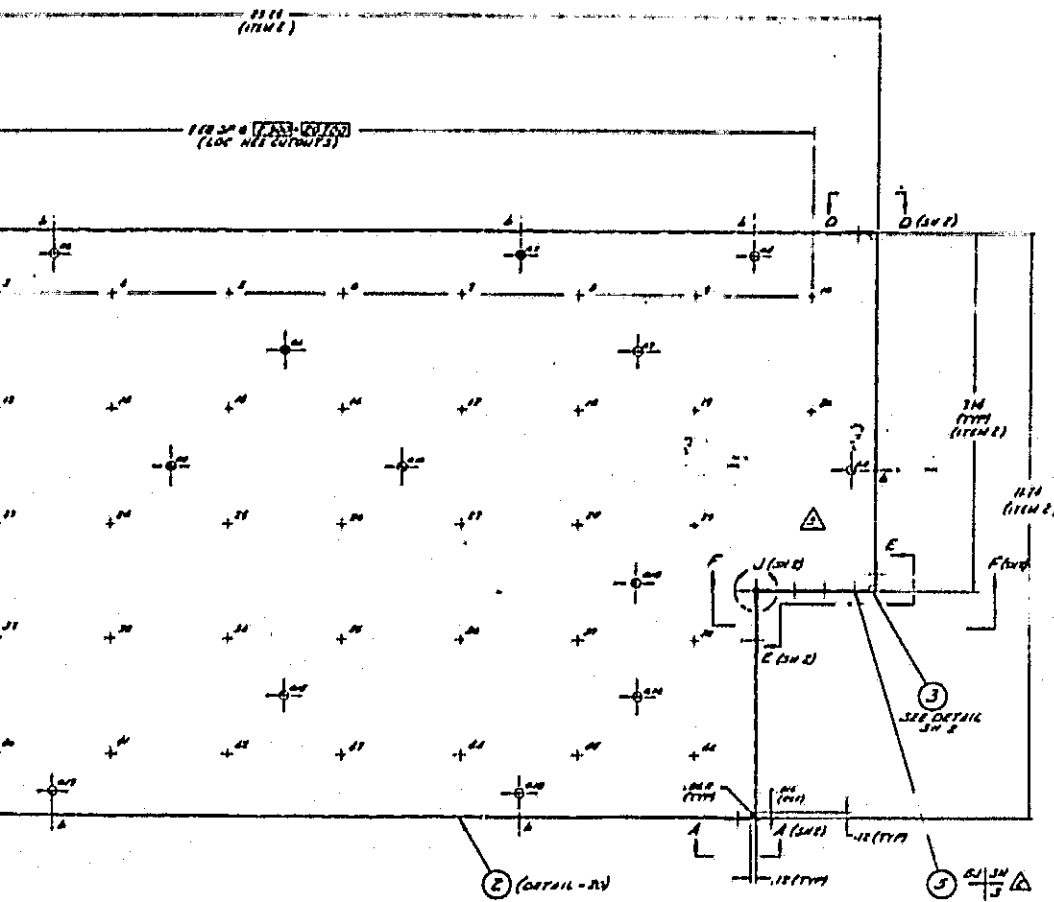
- △ WFC - AND JUD AS DIV 0010-03 PCD 00-010906.
- △ WFC146 DIV 075 00-00 SQUEESED DOWN
- △ THERE IS NO POSITION JUD,
- △ GULLY OF MOUNTAIN AND CUTOFF (24,25,26,27,28,29)
- △ IS ANTICIPATED OUT OF SEQUENCE.
- △ A DIV WOULD RECONSTRUCT OF POSITIONS 10,11,12,13,20
- △ FOR POSITION 14-15 WOULD RECONSTRUCT THEM AS
- △ SEQUENTIAL CONNECTION POSITIONS, 12, 13, AND 14-15-16.
- △ WFC - AND JUD AS DIV 0010-03 PCD 00-010906/11



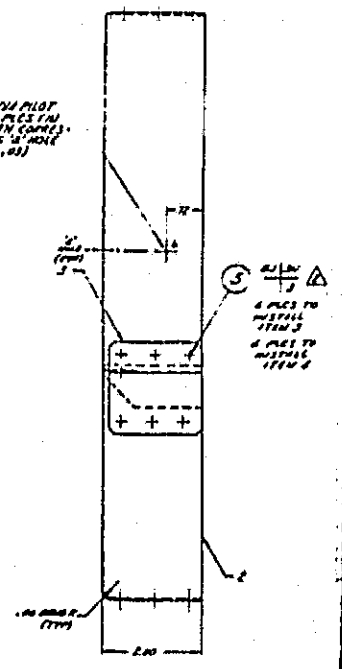
NET CUTOFF GENERATION	ROTATION P. C. G.	TOL	NET CUTOFF GENERATION	ROTATION P. C. G.	TOL
1	5	2.750	22	235.714	2.750
2	59.648		23	194.901	
3	52.519		24	190.416	
4	112.116		25	186.101	
5	143.131		26	182.000	
6	131.687		27	178.125	2.750
7	606.152		28	174.444	2.750
8	133.818		29	170.938	
9	188.479		30	167.586	
10	212.127		31	164.375	
11	225.115		32	161.296	
12	101.030		33	158.333	
13	21.718		34	155.476	
14	166.900		35	152.714	
15	178.448		36	150.000	
16	184.310		37	147.391	
17	29.000		38	144.878	
18	116.114		39	142.461	
19		2.750	40	140.143	

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PROF HOLES 1/2" DIA PLCS
IN 1/8" DIA. SEE SIDE VIEW
FOR DIMS.



PROF HOLES 1/2" DIA
PLCS IN 1/8" DIA. SEE
SIDE VIEW FOR DIMS.
SEE DETAIL IN 2



① -GLASSY

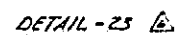
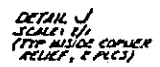
TABLE II

HOLE DESIGNATION	HOLE SIZE	X (INCH)	Y (INCH)	Z (INCH)
H1	1/2 DIA	0.150	0.150	0.150
H2	1/2 DIA	0.150	0.150	0.150
H3	1/2 DIA	0.150	0.150	0.150
H4	1/2 DIA	0.150	0.150	0.150
H5	1/2 DIA	0.150	0.150	0.150
H6	1/2 DIA	0.150	0.150	0.150
H7	1/2 DIA	0.150	0.150	0.150
H8	1/2 DIA	0.150	0.150	0.150
H9	1/2 DIA	0.150	0.150	0.150
H10	1/2 DIA	0.150	0.150	0.150
H11	1/2 DIA	0.150	0.150	0.150
H12	1/2 DIA	0.150	0.150	0.150
H13	1/2 DIA	0.150	0.150	0.150
H14	1/2 DIA	0.150	0.150	0.150
H15	1/2 DIA	0.150	0.150	0.150
H16	1/2 DIA	0.150	0.150	0.150
H17	1/2 DIA	0.150	0.150	0.150
H18	1/2 DIA	0.150	0.150	0.150
H19	1/2 DIA	0.150	0.150	0.150
H20	1/2 DIA	0.150	0.150	0.150
H21	1/2 DIA	0.150	0.150	0.150
H22	1/2 DIA	0.150	0.150	0.150
H23	1/2 DIA	0.150	0.150	0.150
H24	1/2 DIA	0.150	0.150	0.150
H25	1/2 DIA	0.150	0.150	0.150

ITEM	DESCRIPTION	QTY	UNIT	PRICE	TOTAL
1	1/2 DIA HOLE	1	PC	0.150	0.150
2	1/2 DIA HOLE	1	PC	0.150	0.150
3	1/2 DIA HOLE	1	PC	0.150	0.150
4	1/2 DIA HOLE	1	PC	0.150	0.150
5	1/2 DIA HOLE	1	PC	0.150	0.150
6	1/2 DIA HOLE	1	PC	0.150	0.150
7	1/2 DIA HOLE	1	PC	0.150	0.150
8	1/2 DIA HOLE	1	PC	0.150	0.150
9	1/2 DIA HOLE	1	PC	0.150	0.150
10	1/2 DIA HOLE	1	PC	0.150	0.150
11	1/2 DIA HOLE	1	PC	0.150	0.150
12	1/2 DIA HOLE	1	PC	0.150	0.150
13	1/2 DIA HOLE	1	PC	0.150	0.150
14	1/2 DIA HOLE	1	PC	0.150	0.150
15	1/2 DIA HOLE	1	PC	0.150	0.150
16	1/2 DIA HOLE	1	PC	0.150	0.150
17	1/2 DIA HOLE	1	PC	0.150	0.150
18	1/2 DIA HOLE	1	PC	0.150	0.150
19	1/2 DIA HOLE	1	PC	0.150	0.150
20	1/2 DIA HOLE	1	PC	0.150	0.150
21	1/2 DIA HOLE	1	PC	0.150	0.150
22	1/2 DIA HOLE	1	PC	0.150	0.150
23	1/2 DIA HOLE	1	PC	0.150	0.150
24	1/2 DIA HOLE	1	PC	0.150	0.150
25	1/2 DIA HOLE	1	PC	0.150	0.150

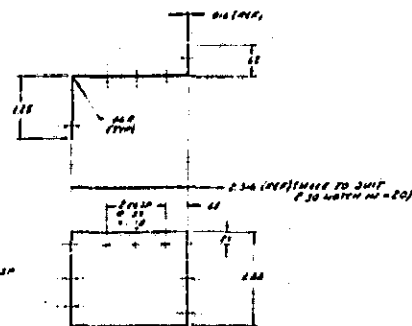
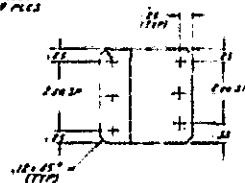
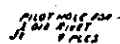
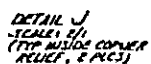
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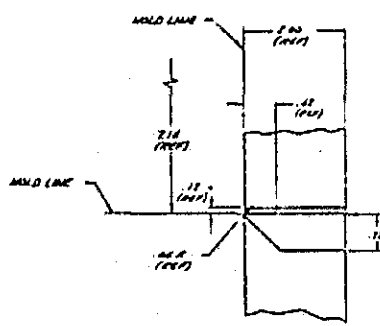


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OR.

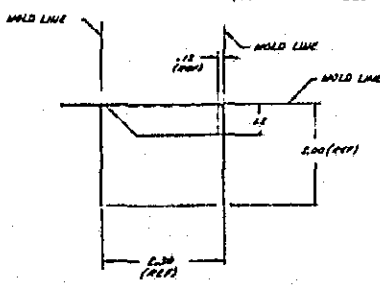
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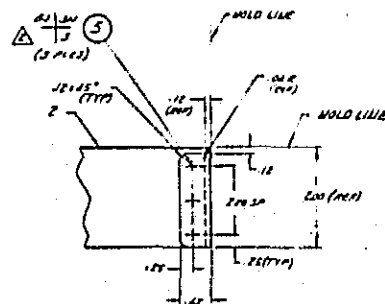
DETAIL - 21 (ITEM 3) SHOWN
- 22 (ITEM 4) OPP



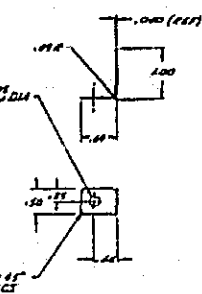
VIEW E-E SHOWIN
(ITEM 3 OMITTED)
VIEW G-G OPP
(ITEM 4 OMITTED)



VIEW F-F SHOWN
(ITEM 3 OMITTED)
VIEW H-H opp
(ITEM 4 OMITTED)



VIEW A-A SHOWN
VIEW B-B OPP
VIEW C-C SAME AS A-A, EXCEPT ROTD 150°
VIEW D-D SAME AS B-B, EXCEPT ROTD 150°



DETAIL-23 

SEE SH 1 FOR P2PTS LIST

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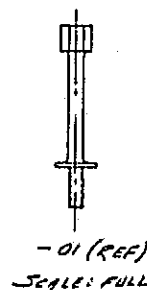
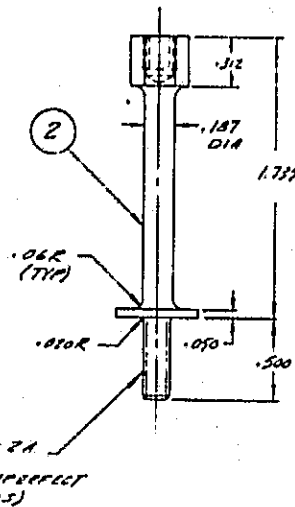
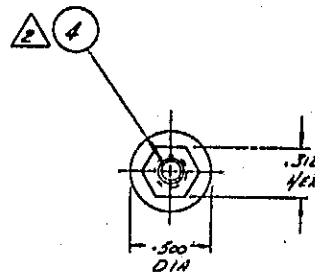
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NOTES:

1. SURFACE ROUGHNESS $\sqrt{125}$ ALL MACHINED SURFACES.
2. INSTALL PER 4335537.
3. IDENTIFICATION: BAG & TAG.
4. CHEMICAL CONVERSION COATING, CL3, PER MIL-C-5541.



① - 01 ASSY
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- 21
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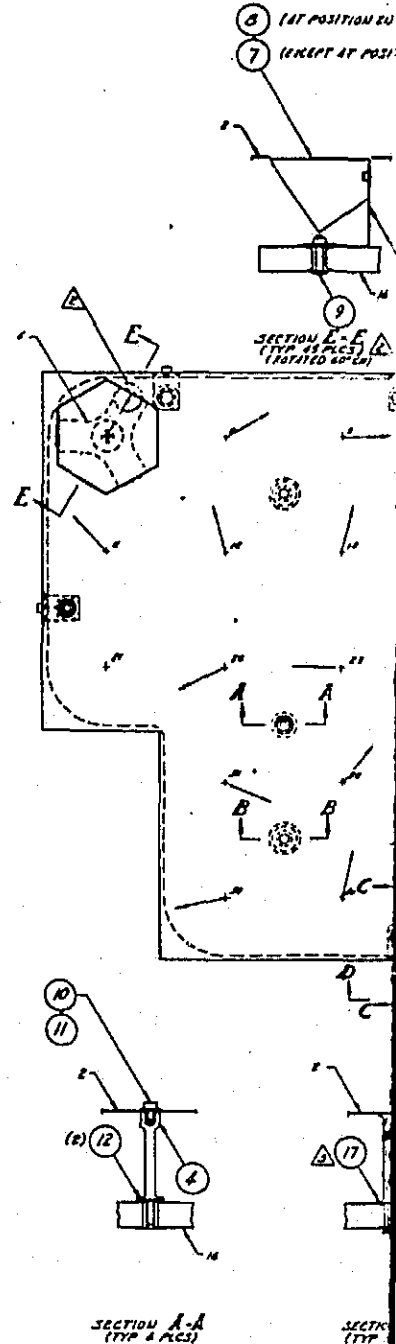
NOTES:

△ REFERRING TO SECTION C-C, TEMPORARILY INSTALL ITEM 3 CLIPS ON ITEM 16 BASE AT 8 LOC'S SHOWN, USING ITEM 4 STANDOFFS. DRILL .125 DIA HOLES AS SHOWN, DISASSEMBLE, THEN COMPLETE INSTALLATION OF PLATE UNITS.

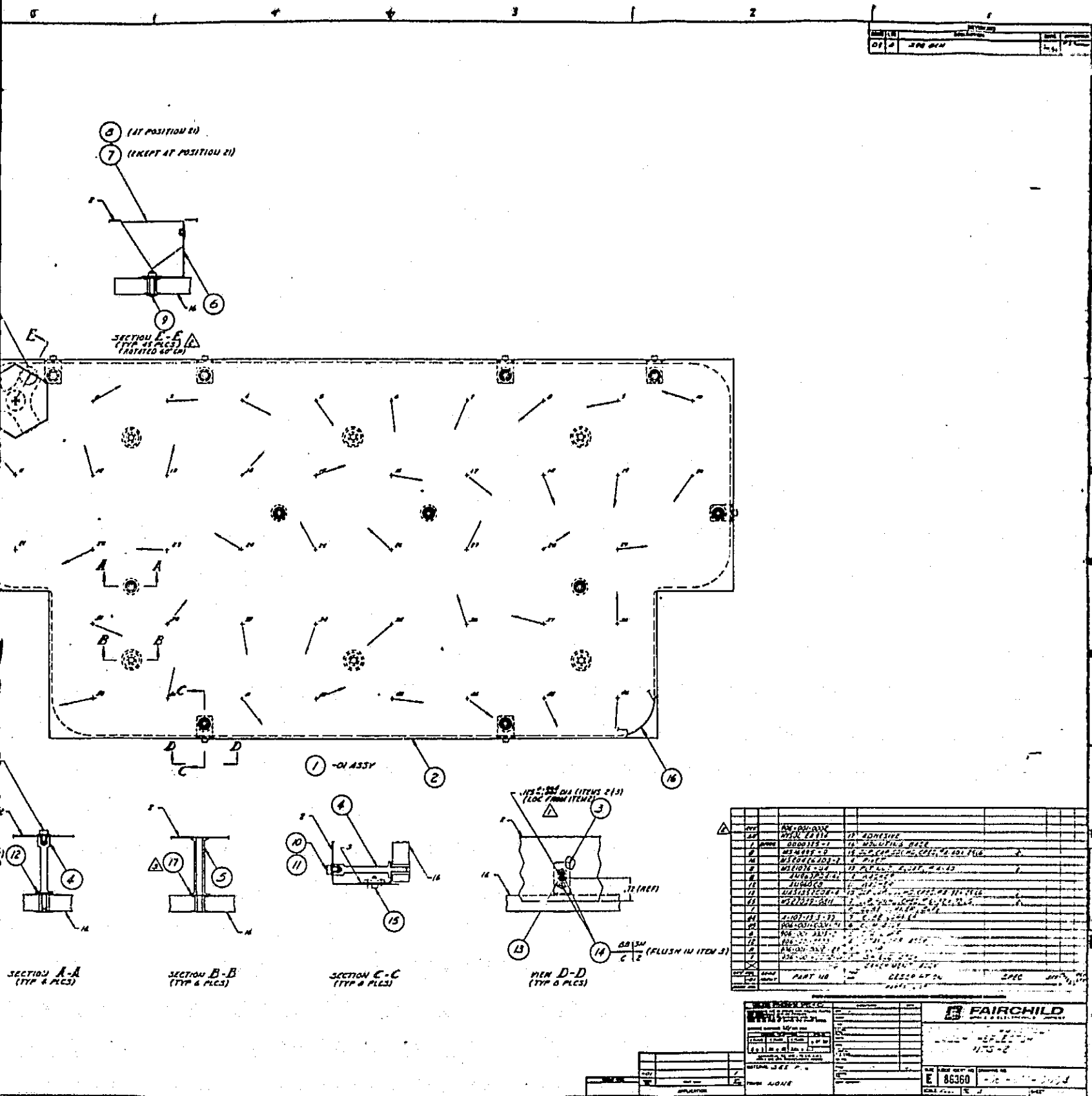
△ ORIENTATION OF ITEM 7 CUBE CORNERS TO BE PER TABLE I OF REF CAG 706-001-0002. CUBE CORNERS TO BE POSITIONED SO THAT CUBE MARK MATCHES DIRECTION ARROW SHOWN, EXCEPT(1) ITEM 8 CUBE CORNER (AT POSITION 21) REQUIRES NO INDEX.

△ BOND ITEM 5 TO ITEM 16, CURING AT ROOM TEMP, INSURE NO ADHESIVE OBSTRUCTS HOLES.

△ OR EQUIVALENT PART.



FOLDOUT FRAME 2

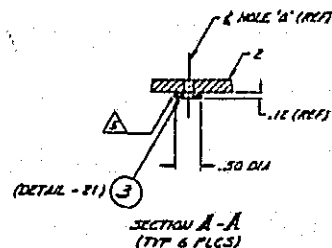
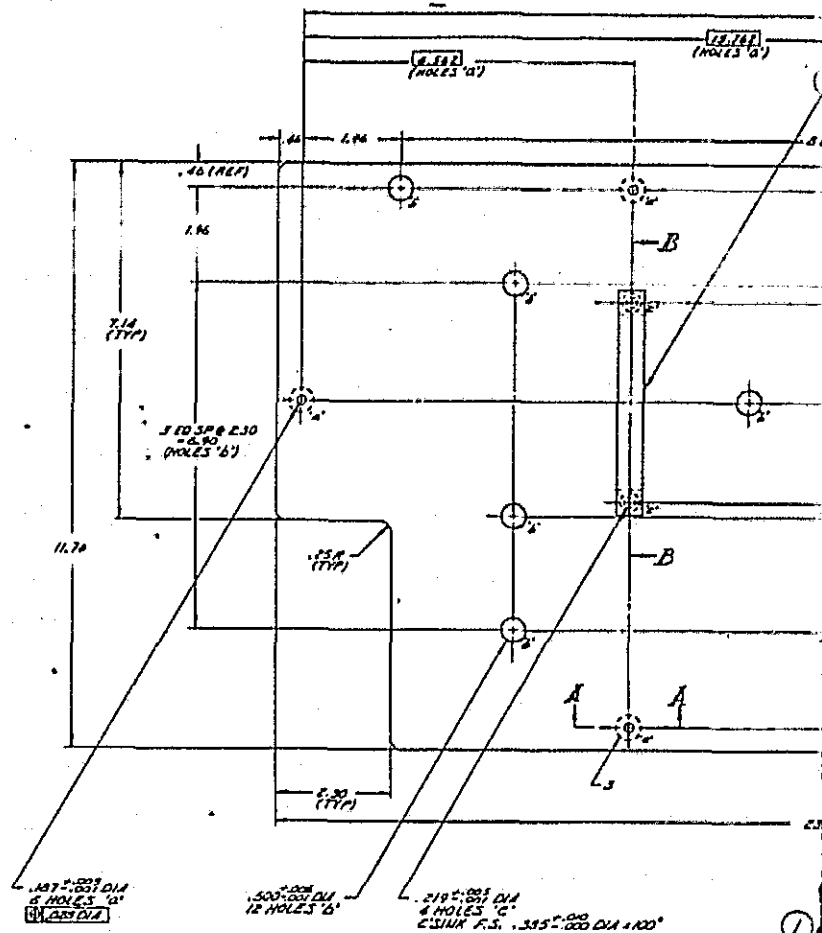


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FOLDOUT FRAME

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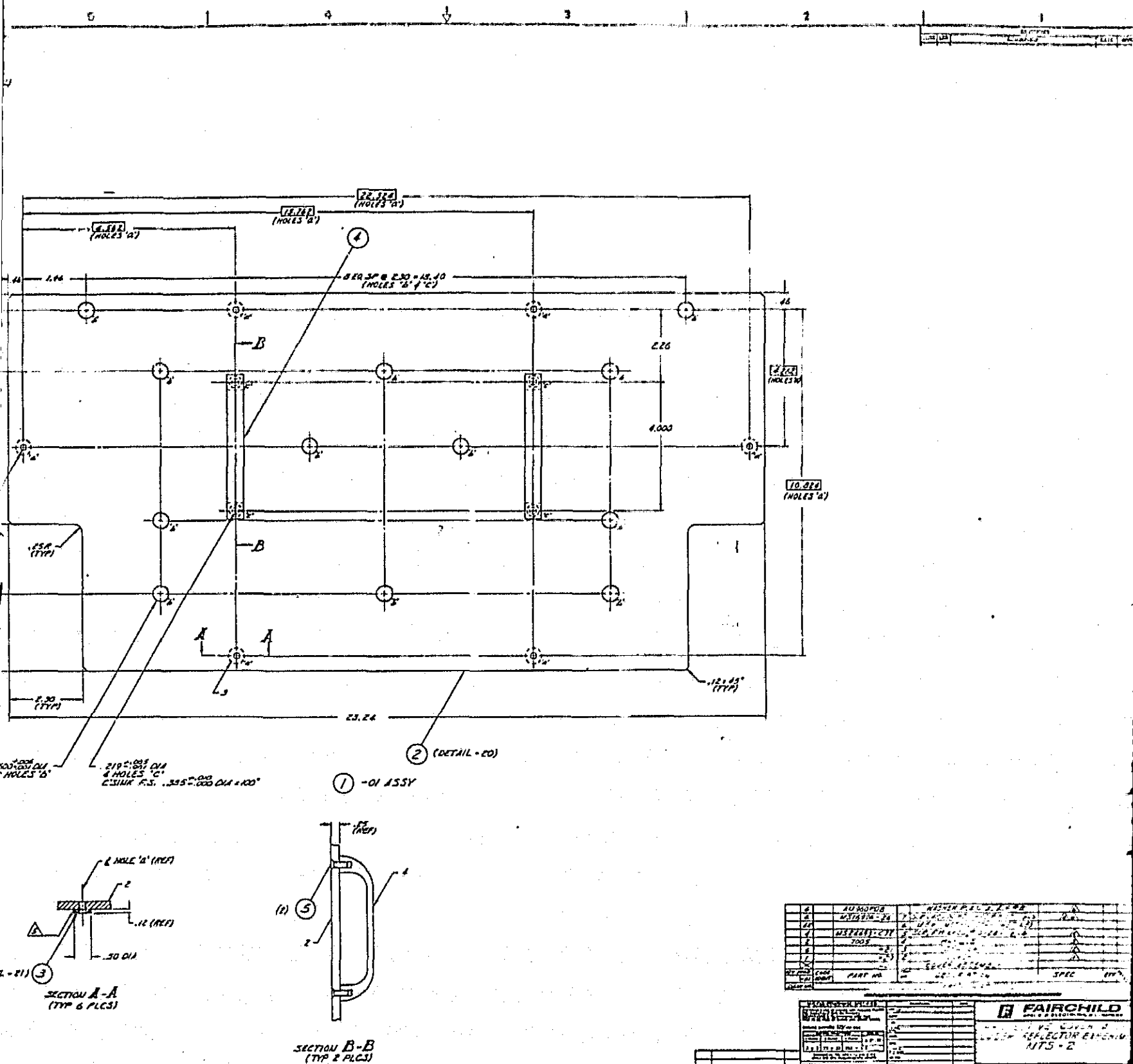
- ▲ MTL 1. 250 THK CLEAR ACRYLIC SHF
PER M/L-P-2105.
- ▲ MTL 1. 125 THK ACRYLIC SHF (COLOR OPTIONAL)
PER M/L-P-2105.
- ▲ FENDOP 1. H.J. GUDEN CO. INC. (OR EQ)
1275 BAKER ST.
COPIAQUE, LI, NY 11726
- ▲ OR EQUIVALENT PART.
- ▲ SOND SPICER (ITEM 5) TO COVER ITEM 2,
USING M/L (ITEM 4).
- ▲ LOOSE PARTS. FURNISH IN BLS, T2D
TO COVER ASSY.



SECTION B-
(TYP & PL)

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